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Dated: March 12, 2007 Signature: (Scott E. Charney)

Docket No.: MOFFAT 3.0-033 (PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Foster et al.

Application No.: 10/795,945

Group Art Unit: 3672

Filed: March 8, 2004

Examiner: K. L. Thompson

For HYBRID COILED TUBING/FLUID
: PUMPING UNIT

CLAIM FOR PRIORITY AND SUBMISSION OF DOCUMENTS

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Applicant hereby claims priority under 35 U.S.C. 119 based on the following prior foreign application filed in the following foreign country on the date indicated:

Country	Application No.	Date
Canada	CA 2421376	March 7, 2003

In support of this claim, a certified copy of the original foreign application is filed herewith.

Dated: March 12, 2007

Respectfully submitted,

By

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PATENTS, TRADEMARKS, COPYRIGHTS & UNFAIR COMPETITION

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March 12, 2007

Mr. Richard Maddrell
Publications International, Ltd.
7373 N. Cicero Avenue
Lincolnwood, IL 60712-1613

Re: PUBINT 3.0-015 CIP DIV
Application No.: 11/414,103
METHOD AND SYSTEM FOR ILLUSTRATING SOUND AND TEXT

Dear Dick:

Please find enclosed a copy of an Amendment and relevant paperwork that were filed today in the United States Patent and Trademark Office for the above-identified matter.

If you have any questions or comments, please feel free to contact us. Thank you for allowing us to be of assistance to you in this matter.

Sincerely yours,

LERNER, DAVID, LITTENBERG,
KRUMHOLZ & MENTLIK, LLP

SCOTT E. CHARNEY

SEC/clg
Enclosures

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Certification

Canadian Patent Office

Certification

La présente atteste que les documents ci-joints, dont la liste figure ci-dessous, sont des copies authentiques des documents déposés au Bureau des brevets.

This is to certify that the documents attached hereto and identified below are true copies of the documents on file in the Patent Office.

Specification and Drawings, as originally filed, with Application for Patent Serial No: **CA 2421376**, on March 7, 2003, by **LEADER ENERGY SERVICES CORP.**, assignee of Robert Joseph Foster and Douglas Costall, for "Hybrid Coiled Tubing/Fluid Pumping Unit".

Agent certificateur/Certifying Officer

CERTIFIED COPY OF PRIORITY DOCUMENT

February 14, 2007

Date

Canada

(CIPO 68)
31-03-04

OPIC CIPO

ABSTRACT

An improved apparatus for the servicing of a bore hole in the earth, comprising a first sub-assembly adapted for the insertion and removal of a continuous length of coiled tubing into and from the bore hole; and a second sub-assembly adapted for the vaporization of liquified gas and the pumping of the resulting gas through the coiled tubing; and platform adapted to support the first and second sub-assemblies thereon.

HYBRID COILED TUBING/FLUID PUMPING UNIT

Field of the Invention

The present invention relates to a coiled tubing unit for use in the servicing of oil and gas wells and more particularly to a unit mounted on a single mobile platform capable of providing both coiled tubing and pressurized fluid injection with non-fired heat recovery.

Background

Well bores require periodic maintenance to remove for example accumulated sediments or for a host of other reasons well known in the industry. When maintenance is required, it is the usual practice to remove existing pumping equipment from the wellhead, and to move in a service rig to maintain control over the well during servicing and to inject and remove the necessary tools and equipment required to complete the maintenance or servicing operations.

For well servicing and workovers, the use of coiled tubing is preferred. Coiled tubing is a single length of continuous unjointed tubing spooled onto a reel for storage in sufficient quantity to exceed the maximum depth of the well being serviced. Coiled tubing is favoured because its injection and withdrawal from the well can be accomplished more rapidly compared to conventional jointed pipe, and it is particularly well suited for use in underbalanced wells. However, as with conventional pipe, service fluids and wire lines for downhole tools and instruments pass through the tubing's interior. The tubing is wound on a reel or spool mounted on a wheeled trailer or the flatbed of a truck for transport. The coiled tubing unit will normally also include an injector for insertion and removal of the tubing from the wellbore and a guidearch which leads the tubing into the injector.

For a typical cleanout, the tubing is injected into the well and a pressurized fluid is pumped through the tubing to circulate the well contents out through the annulus

between the tubing and the well bore. The fluid can be a liquid but is often an inert gas such as air, nitrogen or carbon dioxide.

As a cleanout fluid, air has the obvious advantage that it costs nothing and it works reasonably well particularly in shallow wells of less than 1200 metres in depth. In shallow wells, the ratio of oxygen to hydrocarbons is not critical and there is relatively little risk of explosion. In deeper wells however, partial pressures increase, and the concentration of oxygen and its reactiveness increase sharply. This creates a real risk of explosion and the oxygen's reactiveness can cause sever corrosion by the oxidation of metallic surfaces.

Another disadvantage to the use of air is that the equipment needed to compress and pump it adds substantially to the weight of a coiled tubing rig. A major issue with coiled tubing units is the amount of coil they can carry without exceeding load limits on both the trailer and public roadways. So called "bob tailed" coiled tubing units incorporate the air compressor. The compressors typically pump 300 to 650 standard cubic feet per minute (scfm) at a maximum pressure of approximately 2000 psi. This is not sufficient in itself to blow sand from deeper wells. To add more lifting capacity, soap is added to the air stream which produces a foam. The soap is stored in a tank, and the tank and compressor combined weight approximately 7500 lbs. (approximately 3400 kg), which reduces the amount of coil the unit can carry by the same amount. This limits deeper well applications.

These and other factors mitigate against the use of air for deep well applications and favour the use of nitrogen. Nitrogen is inert at all depths and creates a safer working environment around hydrocarbons. Its also non-corrosive. It is pumped at a volume of up to 1500 scfm at pressures up 5000 psi which is sufficient to blow sediments from the wellbore without the need for soap.

To complete a job using nitrogen, both a coiled tubing unit and a nitrogen unit are required on location. The two units are rigged together at the well site and as the coiled tubing is run into the well, the nitrogen is pumped through the tubing to extrude any fluids and/or solids accumulated in the well.

Nitrogen is normally stored and transported to the site as a liquid in a pressurized container forming part of the nitrogen rig, which also includes a tractor for moving the rig from job to job, a pumping unit and a heating unit to vaporize the nitrogen prior to injection through the coiled tubing and into the wellbore. The heater is normally an open flame unit and by regulation it must therefore be kept at a predetermined safe distance from the wellhead.

The above described setup has numerous disadvantages. Most obviously, operating costs for two rigs are high because of the extra personnel, fuel and equipment required. There is the added pollution and cost resulting from the use of two tractor units and an open flame heater. The mandated separation of the nitrogen and coiled tubing units greatly enlarges the footprint at the well site which sometimes necessitates enlarging the site. The high pressure tubing delivering the nitrogen gas to the coiled tubing unit is a hazard and setup and breakdown times before and after the job are increased.

Summary of the Invention

The present invention seeks to overcome the above disadvantages by providing a hybrid coiled tubing/fluid pumping unit. The hybrid unit consists of a coiled tubing reel and injector, together with a nitrogen rig on a single platform. The nitrogen rig must have a non-fired heat recovery system between the pump and the coiled tubing to vaporize the nitrogen prior to injection.

In operation, the hybrid coil tubing/nitrogen rig is driven to the well site requiring service. The unit has the capability of towing a pup trailer supporting the liquid nitrogen reservoir. Once at the site, the coiled tubing is deployed according to standard procedures known in the art; the tubing is delivered over a guide arch into the injector, and the injector then inserts the tubing into the bore. If the bore is underbalanced, a lubricator can be used in conjunction with the injector.

The outer end of the coiled tubing can be permanently connected to the nitrogen rig, thus eliminating the need to connect tubing which could potentially be a weak spot

in a high pressure line. The permanent connection also limits the amount of high pressure tubing exposed at the work site, making for a safer environment. Because the heater used to vaporize the liquid nitrogen is non-fired, it can be deployed on the hybrid unit immediately adjacent the well bore, which greatly reduces the onsite footprint.

It is therefore an object of the present invention to provide a hybrid rig for a well comprising a coil tube spool; coiled tubing wound about said spool; a mast with a guide arch for guiding the coiled tubing; an injection head for injecting said coiled tubing into said well; and a pump for pumping fluid through said coiled tubing, wherein said spool, mast and pump are affixed to a single platform.

Brief Description of the Drawings

Preferred embodiments of the present invention will now be described in greater detail and will be better understood when read in conjunction with the following drawings, in which:

Figure 1 is a perspective view of a well site set up for servicing using conventional nitrogen and coiled tubing units;

Figure 2 illustrates a conventional nitrogen rig;

Figure 3 shows a portion of the rig of Figure 2;

Figure 4 is a side elevational partially schematical view of a hybrid coil tubing/pumping unit;

Figure 5 is a perspective view of a partially assembled nitrogen rig forming part of the present invention;

Figure 6 is another perspective view of the nitrogen rig of Figure 5; and

Figure 7 is a hydraulic schematic of the nitrogen rig.

Detailed Description of the Preferred Embodiments

Reference is now made to the drawings. Figures 1 to 3 show prior art rigs and the ways these rigs are used. In particular, Figure 1 shows a typical setup for a coil tubing unit 10 and a nitrogen rig 30.

Coil tubing unit 10 is situated adjacent to wellhead 5. The rig consists of a mobile tractor/trailer unit 9 fitted with a spool 12 for coiled tubing 14, a boom mounted guide arch 16 and a tubing injector 20 that inserts and removes the coiled tubing from the well bore. As will be appreciated, the tubing unit is shown in its working position. For transport and storage, the boom 18 is used to withdraw the guide arch and injector into a stored position on top of the trailer as best seen in Figure 4.

A conventional stand-alone nitrogen rig 30 is best seen in Figures 2 and 3 and includes its own tractor trailer 31 with the trailer supporting a tank 32 for liquid nitrogen, a flame fired heater 36 for vaporizing the nitrogen and a high pressure pump 34 for pumping liquid nitrogen from tank 32 into the heater and then into and through the tubing. The pump will normally use the tractor's motor for power.

As seen most clearly in Figure 1, the nitrogen rig is physically separated from the coiled tubing unit and the wellhead by the mandated distance required by law. The two units are rigged together using a high pressure line 38 to deliver pressurized gas from the pumper into the coiled tubing for injection down the well bore. If additional nitrogen is needed, rig 30 can be outfitted with a pup trailer 39 as shown in Figure 2.

Reference is now made to Figure 4 showing the hybrid unit 50 of the present invention which provides both tubing and pumping operations from a single platform. In Figure 4, like numerals have been used to identify like elements.

The hybrid unit of the present invention includes all of the components of a conventional coiled tubing unit including spool 12, guide arch 16, injector 20 and boom 18 to deploy the arch and injector from the storage position shown in Figure 4 to the operational position shown in Figure 1. Unlike conventional rigs, however, the present unit also includes its own integrated nitrogen rig or skid 40 mounted on a sub-frame 48 that can be conveniently and securely attached to the unit's trailer in any known fashion.

In one embodiment constructed by the applicant, rig 40 weighs approximately 2650 lbs. (approximately 1200 kg) compared to the 7500 lb. (approximately 3400 kg) weight of a combined air compressor and soap tank. The nitrogen rig will be described in greater detail below but it generally comprises a nitrogen pump 44, a heat exchanger 46 for vaporizing the liquid nitrogen and a water brake 47 used to load the truck's engine for increased heat production. Heat exchanger 46 is flameless for safety reasons. As aforesaid, regulations require that no flame be present within a predetermined distance of the wellhead. By using a flameless heater, hybrid unit 50 can be situated immediately adjacent the well in the same manner as a conventional coiled tubing unit.

Reference will now be made to Figure 7 for more detailed description of nitrogen rig 40. The nitrogen is transported to the site as a compressed liquid which must be vaporized prior to injection into the well for clean outs. Assuming that up to 90,000 cubic feet of nitrogen gas will be pumped per hour, approximately 1.7 million british thermal units (btu) of heat per hour will be required to vaporize this amount of nitrogen. Some of this heat can be obtained from the truck's engine up to approximately 250,000 btu's with the bulk of the remaining heat being obtained from water brake 47, with perhaps some additional heat being scavenged from the hydraulic fluid used throughout the unit.

Power for the hybrid rig is taken from the truck's engine. As will be known in the art, the truck's gearbox will have at least two auxiliary power take-offs. One is used to drive the coiled tubing hydraulics including the injector and the boom. This is a conventional hookup and therefore will not be described in further detail. The gearbox's other power outlet is used to supply driving force to the nitrogen rig.

The nitrogen rig includes its own gearbox having two outlets. The first is used to mechanically couple water brake 47 to the truck's engine. The second outlet is used to drive the skid's hydraulics which include nitrogen pump 44, a boost pump 43 which is sometimes used to boost pressure to pump 44's intake and a centrifugal pump 60 which circulates fluid through the heat exchange apparatus used to vaporize the liquid nitrogen as will now be described below.

Pump 44 pumps liquid nitrogen from tank 32 through high pressure supply line 45 into heat exchanger 46. A smaller boost pump 43 between tank 32 and pump 44 is

actuated as required to ensure a continuous supply of liquid nitrogen at pump 44's intake and to boost pressure at the intake. The liquid nitrogen is vaporized in the heat exchanger and the resulting gas flows through conduit 49 which can be permanently or semi-permanently coupled to the outer end of coiled tubing 14.

Heat exchanger 46 includes an inlet 52 for hot fluid, which can be water but more typically will be glycol or a water/glycol mixture, and an outlet 53 for cold fluid. To heat the glycol, heat is derived from two principal sources, the truck's cooling system and water brake 47.

To maximize the production of heat from the truck engine's cooling system, it's necessary that the engine be fully loaded. Some of this load will come from the engine's peripherals such as the alternator, water pump and so forth, and some from the power required for the coiled tubing's hydraulics. These loads are not sufficient by themselves however to cause the engine to produce its maximum horsepower and heat output. The engine is therefore mechanically coupled to water brake 47 to produce the required added load.

Water brakes are well known in the art and therefore will not be described in great detail. Generally however they comprise a sealed chamber that is normally kept full of water. A plurality of radially extending, shaft mounted blades or impellers are disposed to rotate within the chamber against the resistance of the water. The shaft is rotated by the motor being loaded. The mechanical energy from the spinning blades is converted to heat energy in the water which is continuously circulated through the chamber to cool the water brake and its seals and to produce hot water for circulation through heat exchanger 46.

The present system incorporates a pump such as centrifugal pump 60 which circulates the glycol throughout the system. The pump is connected at its intake end to two sources of hot glycol. The first is supply line 56 which delivers hot engine coolant that flows into the system through hose 57 and an engine exchange manifold 58. The second source is supply line 64 that delivers hot glycol from glycol tank 65.

Pump 60 forces the hot glycol through a filter 66 following which the flow is split up to three different ways. Part of the glycol is deviated into inlet 52 of heat exchanger

46. Another part is divided into a 1 inch feed line 69 that flows into water brake 47. A smaller portion is diverted into 1/4 inch lines 71 and 72 that connect with 1/8 inch orifices inside the water brake that divert glycol against the water brake's seals when the water brake runs empty as will be described below in greater detail. Glycol entering the water brake through lines 69 and 71 and 72 drains through line 75 which flows back into glycol tank 65.

The cold fluid leaving heat exchanger 46 is circulated through line 77 in which it can be delivered directly to engine exchange manifold 58 for circulation back into the truck's cooling system and then to pump 60. Or, if valve 80 is closed, the fluid can be diverted through hydraulic heat exchanger 84. This exchanger can be used to scavenge heat from hot hydraulic fluid circulated through the exchanger via inlet 85 and outlet 86.

The flow rate through the heat exchanger is approximately 295 gallons of glycol per minute.

There are times when its unnecessary to operate the water brake. In conventional systems, this requires a gearbox to disengage the brake from the truck's engine. These gearboxes however are heavy and expensive. To avoid this, the present water brake has been adapted to run empty. Normally, this will cause the brake and its seals to burn out.

In the present system, the brake's aluminum housing is hardened to 85 Rockwell, and supply lines 71 and 72 continuously deliver a small amount of glycol to 1/8 inch orifices which direct the glycol against the seals. When valve 90 is closed to stop the delivery of glycol to the water brake, pressurized air (7 to 10 psi) from an expansion tank 94, arranged above and in fluid communication with glycol tank 65 through a 2 inch connecting line 97, flows through oneway check valve 98 and through air hose 96 into line 69 to purge the water from the brake. Check valve 98 prevents any reverse flow of glycol into the expansion tank when valve 90 is open during normal operation. Without water, the water brake simply spins without loading the truck's engine. The additional hardening of the water brake's housing and the continuous flow of glycol against the seals prevents burnout.

In operation, hybrid unit 50 can tow its own trailer 39 supporting a liquid nitrogen tank 32. At the well site, the trailer is disconnected from the unit and conveniently located for connection to pump 44.

As will be appreciated from the foregoing, the hybrid unit is largely self-contained, quickly set up and broken down, occupies a small footprint, requires only one crew, one motor and enhances on-site safety.

The above-described embodiments of the present invention are meant to be illustrative of preferred embodiments of the present invention and are not intended to limit the scope of the present invention. Various modifications, which would be readily apparent to one skilled in the art, are intended to be within the scope of the present invention. The only limitations to the scope of the present invention are set out int the following claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. Apparatus for the servicing of a bore hole in the earth, comprising:

a first sub-assembly adapted for the insertion and removal of a continuous length of coiled tubing into and from said bore hole; and

a second sub-assembly adapted for the vaporization of liquified gas and the pumping of the resulting gas through said coiled tubing; and

platform means adapted to support said first and second sub-assemblies thereon.

2. The apparatus of claim 1 wherein said second sub-assembly includes heat exchanger means for vaporization of said liquified gas, said heat exchanger means allowing heat transfer between a heated fluid and said liquified gas.

3. The apparatus of claim 2 wherein said heated fluid is heated in part by waste heat from an internal combustion engine.

4. The apparatus of claim 3 wherein said second sub-assembly additionally includes means for loading said internal combustion engine to increase its output of heat.

5. The apparatus of claim 4 wherein said means for loading comprise a water brake drivingly connected to said internal combustion engine.

6. The apparatus of claim 5 wherein said heated fluid is circulated through one or both of said internal combustion engine and said water brake for the transfer of heat to said heated fluid, the said water break having a first inlet for said heated fluid and an outlet for the discharge thereof.

7. The apparatus of claim 6 additionally comprising a first reservoir having an inlet for receiving said heated liquid from said outlet of said water brake and an outlet for the discharge of said heated fluid to said heat exchanger.

8. The apparatus of claim 7 additionally comprising a second reservoir having first and second inlets and first and second outlets, said first inlet being in fluid communication with said internal combustion engine to receive said heated fluid therefrom, said first outlet being in fluid communication with said internal combustion engine for the return of said heated fluid thereto, said second outlet being in fluid communication with an inlet to said heat exchanger for the delivery of said heated fluid thereto, and said second inlet being in fluid communication with an outlet of said heat exchanger to receive heated fluid therefrom.

9. The apparatus of claim 8 including a first pump disposed between said first and second reservoirs and said heat exchanger, said pump having an intake in fluid communication with said outlet of said first reservoir and with said second outlet of said second reservoir, and a discharge in fluid communication with said inlet to said heat exchanger and with said inlet to said water brake.

10. The apparatus of claim 9 wherein said water brake includes second and third inlets, both of which are also in fluid communication with said discharge of said first pump, and both of which are sized for the delivery of a reduced amount of heated fluid into said water brake.

11. The apparatus of claim 10 including valve means disposed between said first pump and said first inlet of said water brake, said valve being operable to stop the flow of said heated fluid into said water brake.

12. The apparatus of claim 11 wherein, when said valve means are closed, heated fluid continues to be discharged in a reduced amount into said water brake through said second and third inlets.

13. The apparatus of claim 12 wherein said heated fluid flowing through said second and third inlets is directed at seals in said water brake for the cooling thereof.

14. The apparatus of claim 13 including an air line for delivering pressurized air into said first inlet of said water brake when said valve means are closed, wherein said pressurized air forces said heated fluid out of said water brake to substantially empty the same.

15. The apparatus of claim 14 wherein said substantially empty water brake reduces loading on said internal combustion engine without being drivingly disconnected therefrom.

16. The apparatus of claim 15 including a third reservoir for said pressurized air, said third reservoir being located above said first reservoir and having an inlet in fluid communication therewith and an outlet for delivery of said pressurized air through said air line to said water brake.

17. The apparatus of claim 16 wherein said air line includes a one-way check valve therein permitting the flow of pressurized air into said water brake but preventing the flow of heated fluid into said third reservoir.

18. The apparatus of any of claims 2 to 17 including a second pump for pumping said liquified gas through said heat exchanger.

19. The apparatus of claim 18 including a tank for said liquified gas.

20. The apparatus of claim 19 wherein said liquified gas is liquified nitrogen.

21. A hybrid coiled tubing and pumping rig for a well comprising:
a coiled tubing spool;
coiled tubing wound about said spool;
a coiled tubing injector for injecting said coiled tubing into said well;
a guide arch for guiding said coiled tubing into said injector; and
a pump for pumping pressurized fluid through said coiled tubing into said well, wherein said spool, injector and pump are supported on a single platform.

22. The hybrid rig of claim 21 further comprising a flameless heating unit between said pump and said coiled tubing.

23. The hybrid rig of claim 22 wherein said flameless heating unit comprises:
a heat exchanger for vaporizing said nitrogen, said heat exchanger allowing heat transfer between a heat exchanging fluid and said nitrogen;
a pump for pumping said heat exchanging fluid; and
reservoirs on said hybrid rig for said heat exchanging fluid, said reservoirs facilitating heat transfer between a cooling fluid from an engine and said heat exchanging fluid, wherein said heat exchanging fluid flows from said reservoirs, through said pump, into said heat exchanger, and back into said reservoirs.

24. The hybrid rig of claim 23, wherein said flameless heating unit further includes a water brake to add a load to said engine, thereby producing more heat in said heat exchanging fluid.

25. The hybrid rig of claim 24, wherein said heat exchanging fluid is further pumped through said water brake, thereby cooling said water brake and further heating said heat exchanging fluid.

26. The hybrid rig of claim 25, wherein said water brake further comprises:

a hardened housing;

seals; and

fluid inlets for said heat exchanging fluid to cool said seals, whereby said hardened housing and said fluid cooled seals allow said water brake to run empty, thereby unloading said engine without disconnecting said water brake from said engine.

27. The hybrid rig of claim 26, wherein said flameless heating unit further includes:

an intake line;

a valve along said intake line, said valve allowing said heat exchanging fluid to flow into said water brake when open and preventing said heat exchanging fluid from flowing into said water brake when closed;

an air line, said air line connected to said intake line between said water brake and said valve;

a one-way check valve along said air line to prevent the reverse flow of said heat exchanging fluid away from said water brake;

a discharge line for taking fluid away from said water brake;

a heat exchanging fluid tank connected to said discharge line; and

an expansion tank connected to said air line and above said heat exchanging fluid tank, said expansion tank allowing air to flow into said water brake, whereby opening said valve allows heat exchanging fluid to flow through said water brake and closing said valve allows air to flow through said water brake.

28. The hybrid rig of any of claims 22 to 27, wherein said flameless heating unit further includes a hydraulic heat exchanger for heating said heat exchanging fluid from a hydraulic system of said hybrid rig.

29. The hybrid rig of any of claims 21 to 28, wherein said hybrid rig is further adapted to tow a tank trailer, said tank trailer holding said pressurized fluid.

30. The hybrid rig of any of claims 22 to 29, wherein said coiled tubing is permanently connected to said flameless heating unit.

31. The hybrid rig of any of claims 21 to 30, wherein said pressurized fluid is liquid nitrogen.

32. The hybrid rig of any of claims 22 to 31, wherein said heat exchanging fluid is water.

33. The hybrid rig of any of claims 22 to 31, wherein said heat exchanging fluid is glycol.

34. The hybrid rig of any of claims 22 to 31, wherein said heat exchanging fluid is a water/glycol mixture.

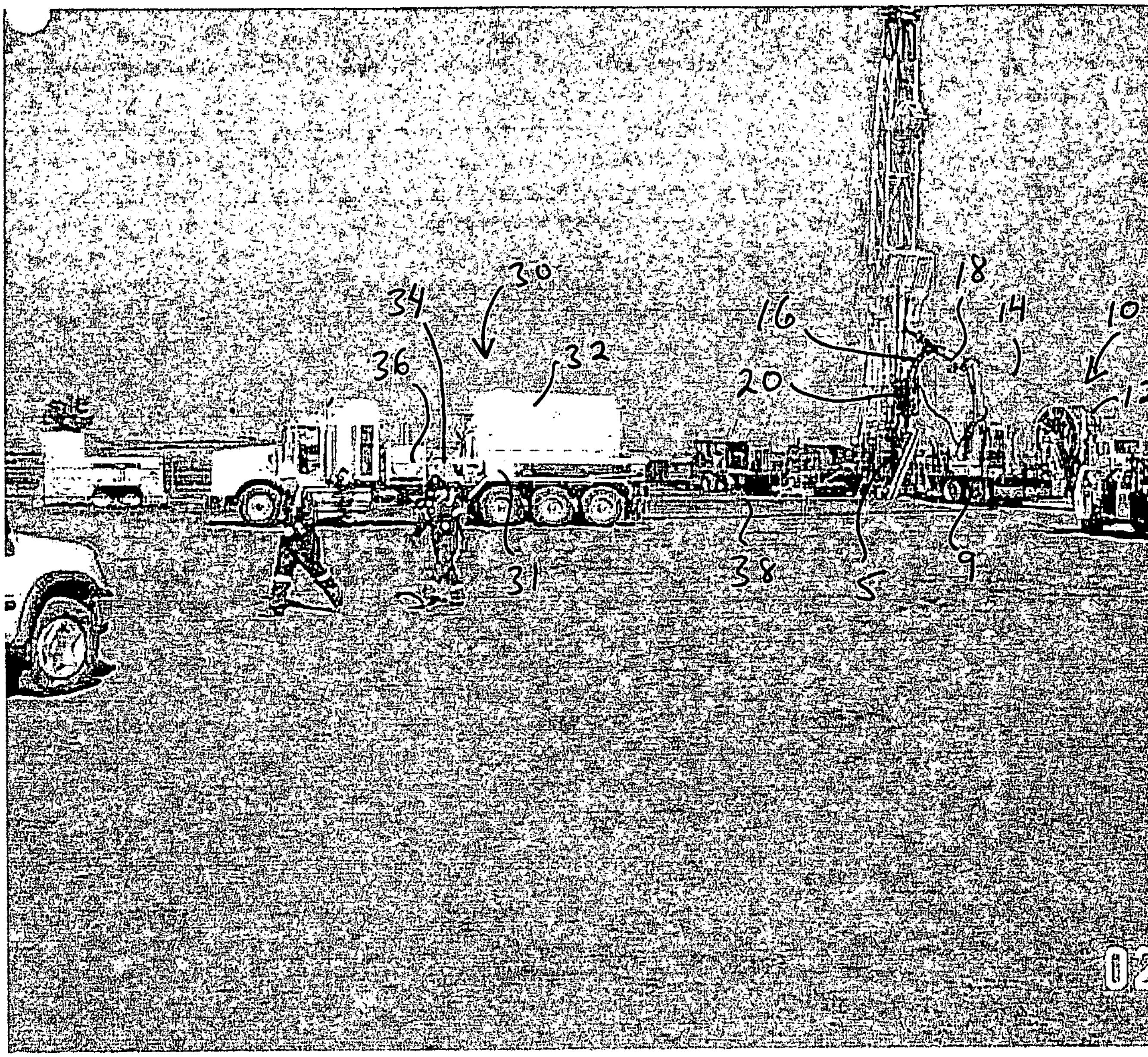


FIGURE 1
PRIOR ART

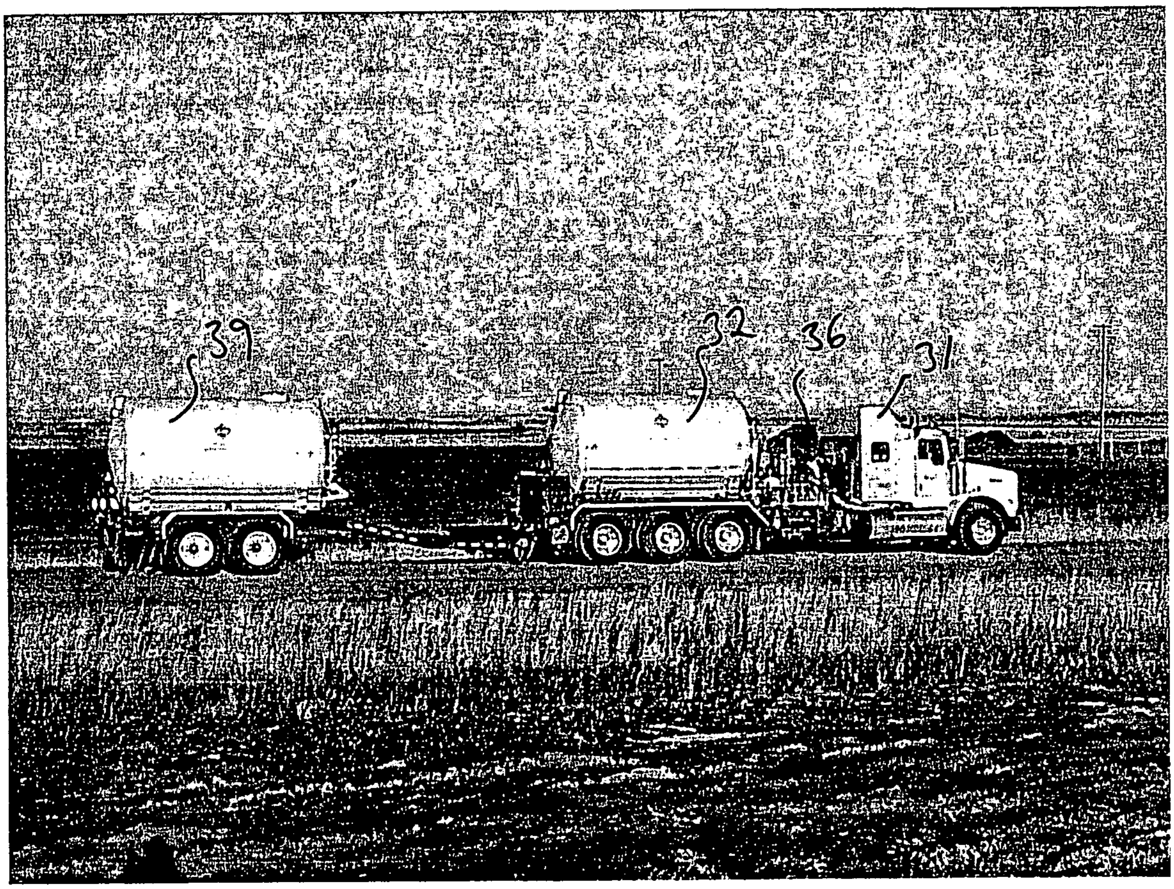


FIGURE 2
PRIOR ART

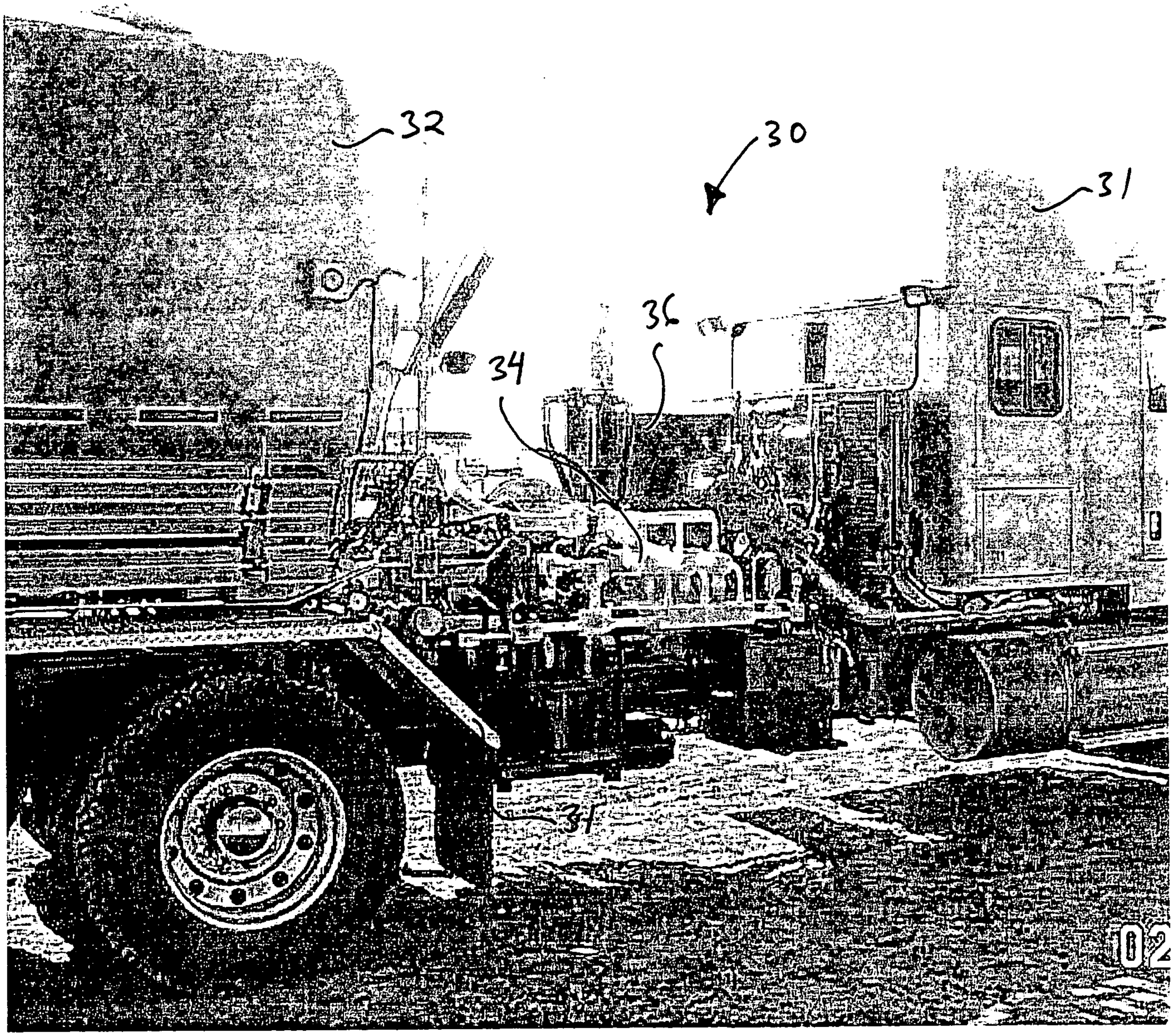


FIGURE 3
PRIOR ART

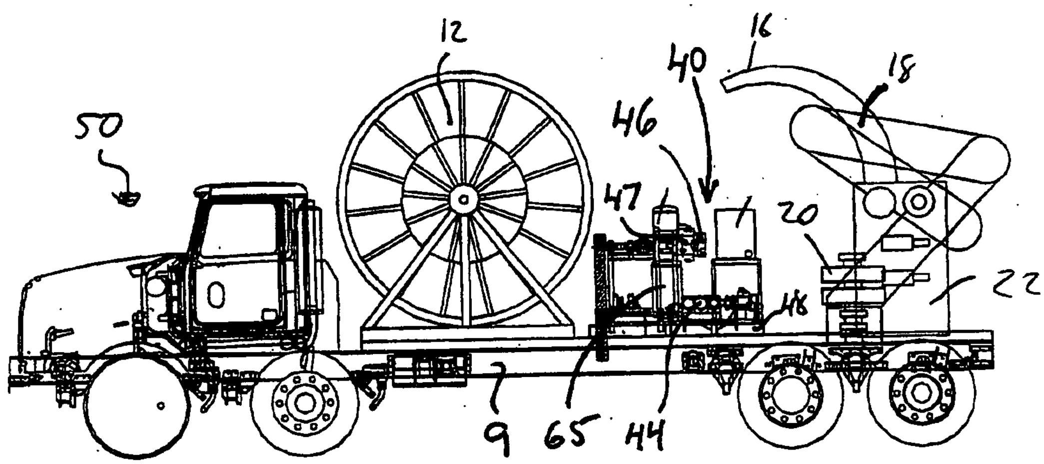


Fig 4.

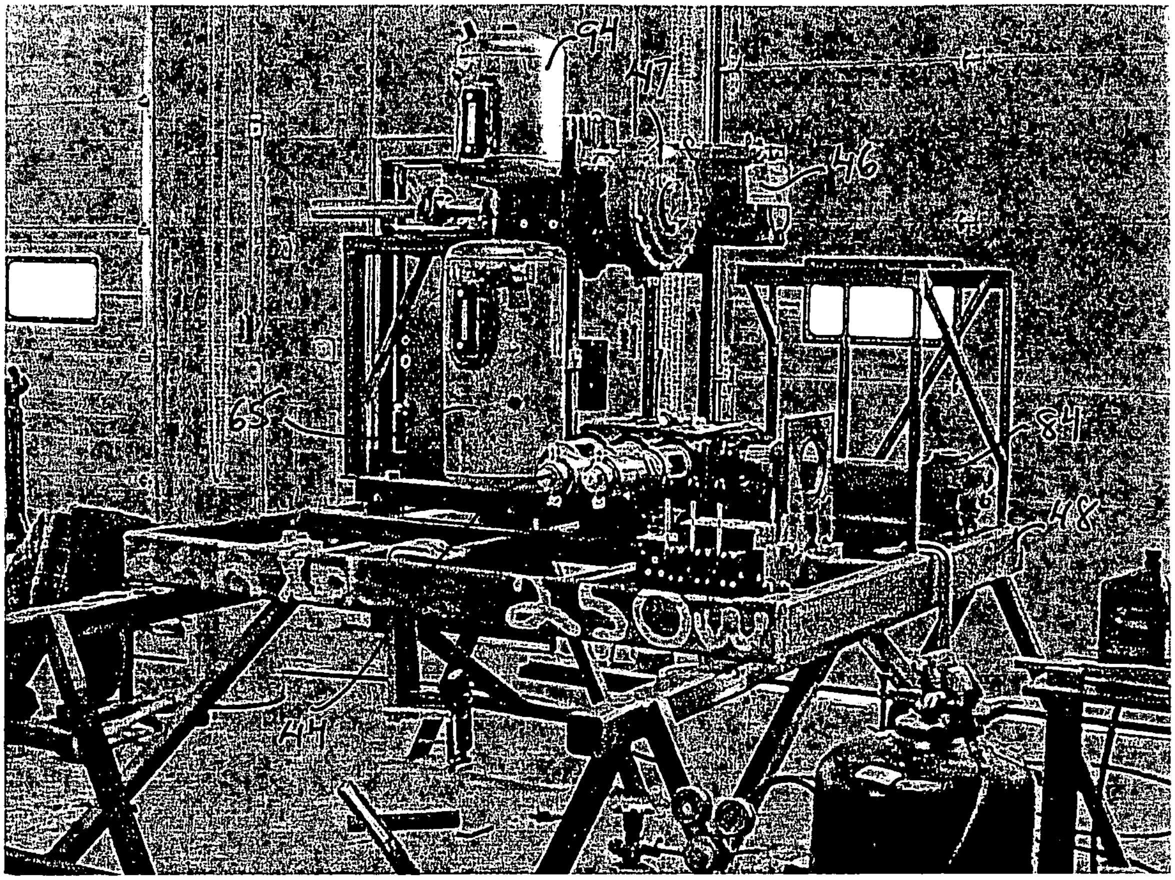


FIGURE 4 5

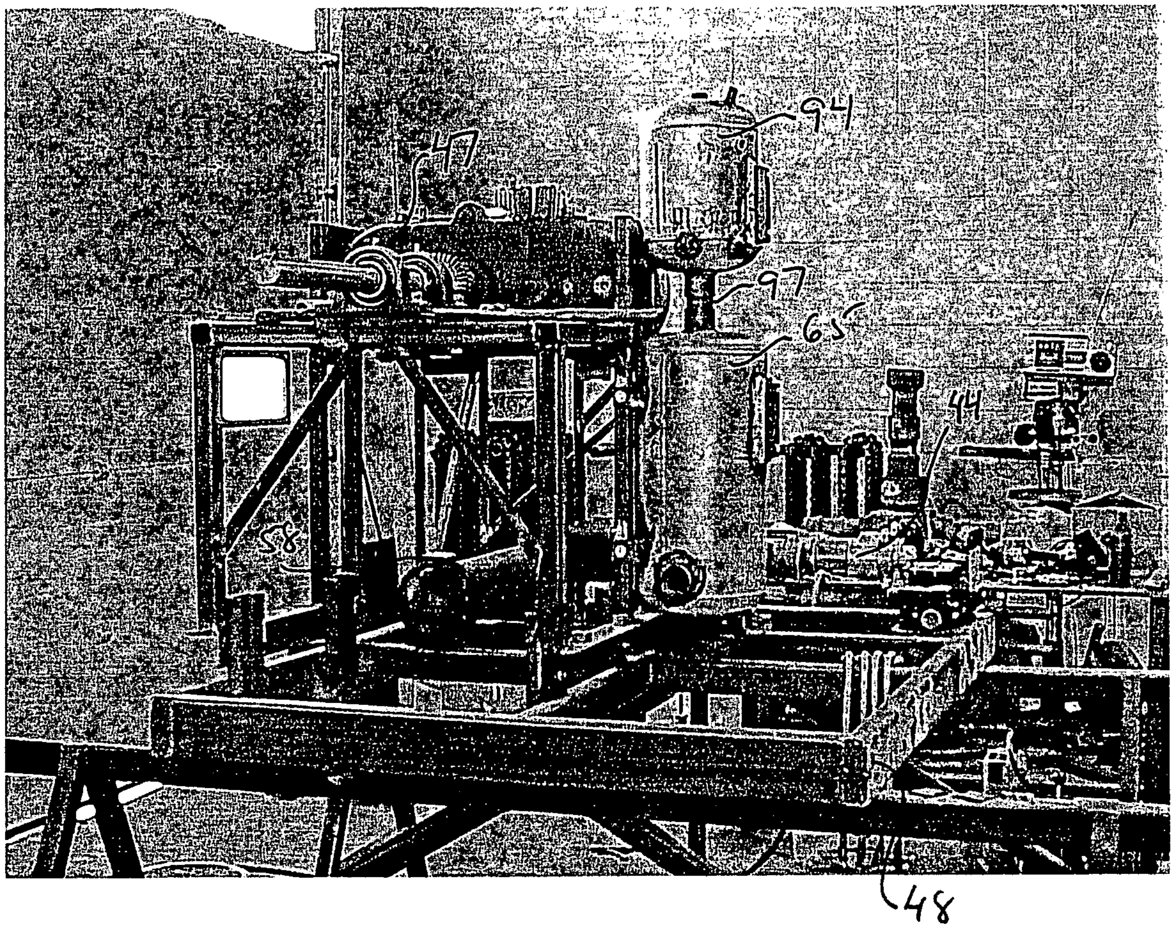
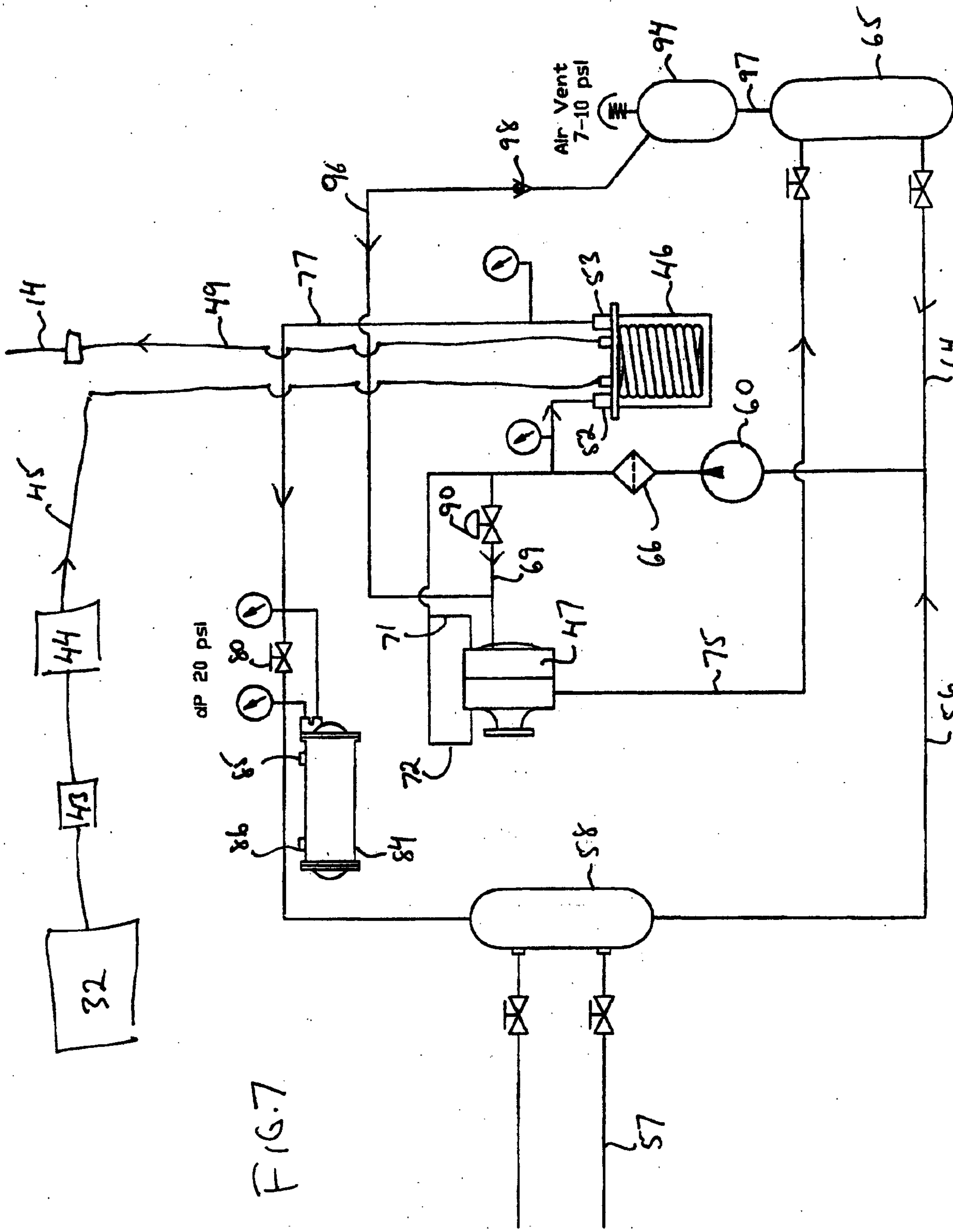


FIGURE 56


Air Vent
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dP 20 psi
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FIG.7